# Chapter 219
# Development and Simulation of Silicon PAD

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## 219.1 Introduction

Silicon detector is a large surface diode with guard rings. The steps below briefly describes the techniques we have used in silicon detector fabrication [1].

1. Thermal Oxidation: The silicon wafer is first cleaned using RCA process and then oxidised by heating the wafer in oxygen environment at a temperature of $\sim$1000 °C.
2. Photolithography: We used photolithography to transfer the pattern(designed by software) from photomask to silicon wafer. Pattering of $SiO_2$ was done using double sided mask aligner.
3. Doping: Ion implantation technique was used to create the p-n junction.
4. Metallisation: Metallisation was done with Aluminium to create contacts and then patterning of Al was done using photolithography.

## 219.2 Simulation Results

In this section we present the results of TCAD simulation. Figure 219.1a shows schematic view of the detector simulated in SILVACO. We first carried out the simulation of detector developed at IIT Bombay as shown in Fig. 219.1b, where $b = 200\,\mu m$, $c = 80\,\mu m$, $d = 45\,\mu m$. Figure 219.1c shows the doping profile and potential distribution of the detector simulated. Figure 219.1b shows the distribution of electric field which is very high at the edge of junction. However, it should be uniformly distributed over the guard rings.

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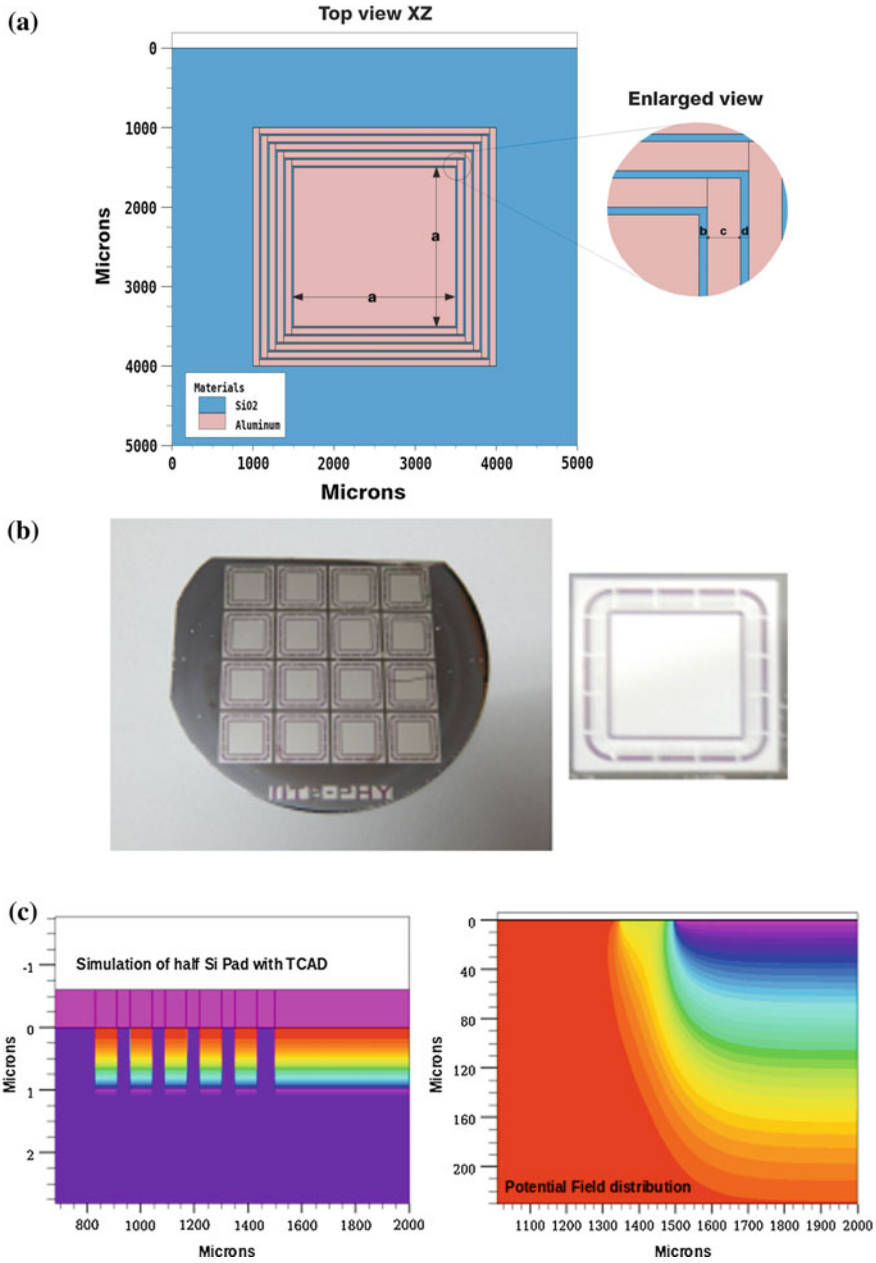


**Fig. 219.1** **a** Schematic view of the detector geometry as simulated in SILVACO, **b** 1 cm × 1 cm Silicon pad developed at IIT Bombay. **c** Doping, Potential and **d** Electric field distribution

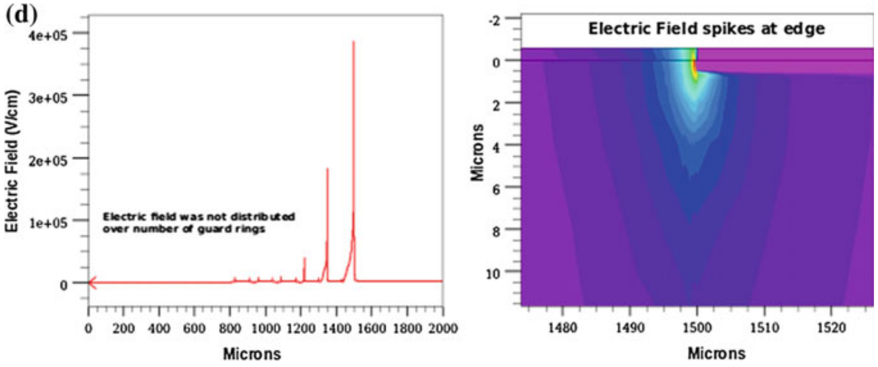
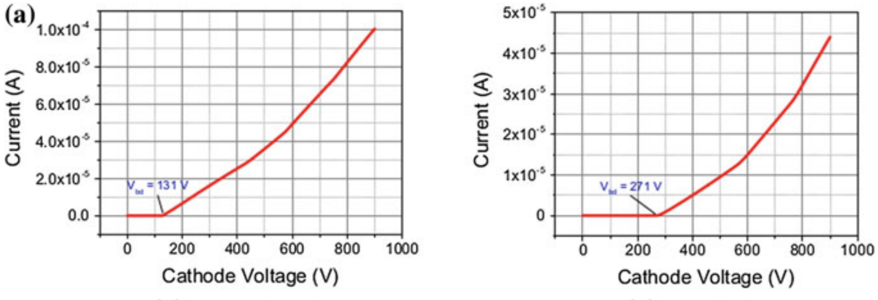
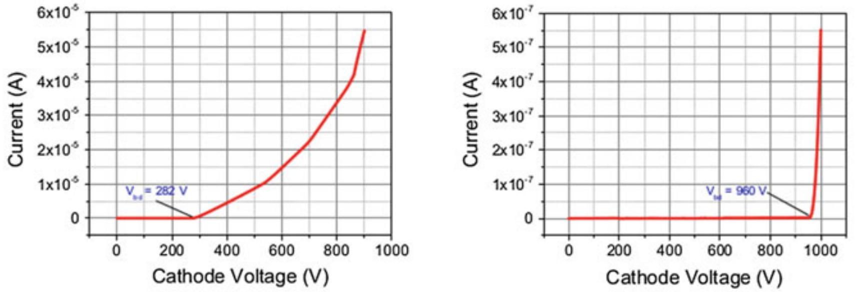


**Fig. 219.1** (continued)



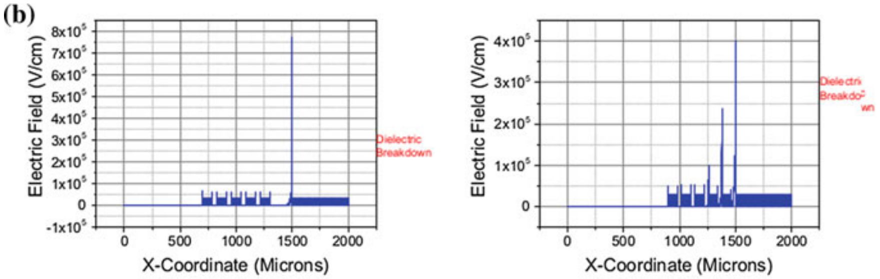
(a) 200 μm gap (b) 40 μm gap



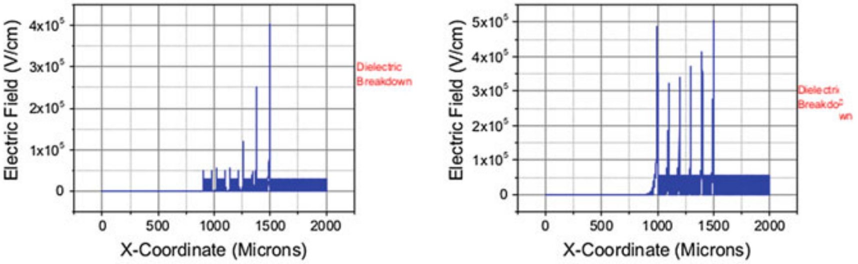
(c) 30 μm gap (d) 20 μm gap

**Fig. 219.2** **a** I-V characteristics of silicon pad detectors with decreasing pitch. and **b** Electric field distribution across the surface at the active-edge to the p+ implantation

To understand the effect of guard rings, we simulated three more geometries. For simplicity, we kept b = d, c = 80 μm and performed simulations for b = 20 μm, 30 μm and 40 μm and found out that, for 20 μm the electric field distribution is



(a) 200 μm gap (b) 40 μm gap



(c) 30 μm gap (d) 20 μm gap

**Fig. 219.2** (continued)

uniform shown in Fig. 219.2b and break down voltage is also high which can be seen in I-V characteristic of detector simulated shown in Fig. 219.2a. But practically, it would be difficult to fabricate 20 μm pitch detector.

## Reference

1. J. Kemmer, Fabrication of low noise silicon radiation detectors by the planar process. Nucl. Instrum. Methods **169**(3) (1980)